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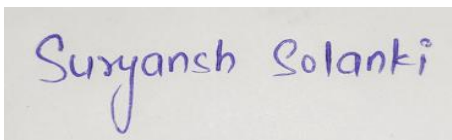
**Annexure3b- Complete filing**

**INVENTION DISCLOSURE FORM**


Details of Invention for better understanding:

**1. TITLE:** IoT-Based Smart Gym Equipment with Real-Time Feedback and Performance Monitoring

**2. INTERNAL INVENTOR(S)/ STUDENT(S):** All fields in this column are mandatory to be filled

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### **3. DESCRIPTION OF THE INVENTION:**

#### **1. Field of the Invention**

The current invention is in the domain of fitness technology and more specifically to Internet of Things (IoT) and artificial intelligence-based gym equipment for real-time performance monitoring, posture adjustment, and exercise optimization.

#### **2. Background of the Invention**

Traditional fitness equipment offers mechanical resistance or support for physical training but without intelligent feedback system mechanism. Users tend to remain oblivious to improper posture or inefficient repetitions, contributing to injuries or poor fitness outcomes. Moreover manual progress monitoring or with simple wearables is not providing detailed data specific to the exercise equipment utilized.

We need an intelligent system capable of monitoring, analyzing, and instructing users in real time while using gym equipment to improve safety, motivation, and performance.

#### **Detailed Description**

##### **a. Hardware components**

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- Sensors Units:
  - Inertial Measurement Units (IMUs) for tracking motion
  - Pressure sensors for grip and seat force analysis
  - Proximity sensors or cameras for posture detection
  - Load cells or strain gauges to measure force applied
- Microcontroller Unit (MCU):
  - Gathers and processes data from all sensors
  - Communicates with mobile app through Wi-Fi or Bluetooth
- Real-Time Feedback Interface:
  - LED signs or display screen on the machine
  - Audio module for voice instruction and notifications

#### **b. Software Components**

- Edge Processing
  - Onboard computing for instant posture verification and form notifications
- Mobile Application:
  - Realtime workout metrics (reps, sets, rest time, calories burnt)
  - Long-term performance analysis and progress reports
  - User profile and workout recommendations by AI
  - Injury risk detection and notification based on anomalies
- Cloud Integration:
  - Stores user workout history securely
  - Gives trainer access for remote monitoring
  - Enables firmware and AI model updates

#### **c. Use Case Scenario**

While working out on a smart bench press:

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- The system senses bar motion speed, shoulder alignment, and grip pressure.
- When posture is not in the optimal range, the system reminds the user to adjust.
- When the user finishes reps, the system records performance data to the mobile app.
- The app then suggests whether to add/subtract weight or rest time in subsequent sessions.

### **Advantages of the Invention**

- Lessens risk of injury by reminding users of incorrect form
- Removes the need for manual workout tracking
- Improves effectiveness of the workout through live coaching
- Encourages users through data insights and tracking of progress
- Supports remote coaching and fitness analysis

### **A. PROBLEM ADDRESSED BY THE INVENTION:**

What a great and timely patent subject! A real-time feedback and performance-tracking IoT-based smart gym equipment system solves quite a few important issues in the world of fitness and wellness. Here are some of the most prominent ones your invention solves:

- **Lack of Objective Performance Data:** Most gym enthusiasts today use subjective sensations or simple metrics such as reps and sets. They do not have detailed, objective information on their form, power output, range of motion, and consistency over time. Your invention offers accurate, quantifiable data for every exercise.
- **Ineffective Workout Regimens:** Without feedback in real-time, people may be doing exercise improperly, which results in less-than-optimal muscle activation and possibly heightened risk of injury. Your system can correct users in real-time to help them use proper form and get the most out of their workouts.
- **Difficulty in Monitoring Progress and Motivation:** Hand-monitoring progress can be inconvenient and usually is not granular enough for efficient analysis. This may result in demotivation and plateaus. Your invention automatically monitors, graphically shows progress, and potentially provides individualized insights and motivation.

- **Limited Personalization and Adaptive Training:** Generic workout routines frequently neglect individual fitness levels, objectives, and physical restrictions. Your intelligent equipment can adjust to the performance level of the user in real-time, modifying resistance, issuing guidance, and possibly even proposing adjustments for a more tailored and efficient training experience.
- **Greater Risk of Injury from Poor Form:** Doing exercises with poor form is a leading cause of gym injuries. Real-time feedback on form can greatly minimize this risk by informing users of deviations and steering them towards correct execution.
- **Limited Remote Monitoring and Guidance:** For those exercising on their own or for those who need remote coaching, there is no real-time sharing of performance data and feedback. Your innovation can fill this gap by allowing remote monitoring by coaches or even AI-based coaching systems.
- **Equipment Features Underutilization:** Most of the sophisticated features on modern gym machines remain underutilized because the users do not understand them or receive no real-time instruction. Your intelligent system can proactively engage the users in using these features and enable them to utilize the maximum capabilities of the equipment.
- **Difficulty in Comparing Performance Over Time and Across Equipment:** It's usually difficult comparing performance between various workout sessions or various equipment owing to insufficient standardization of data collection and comparison. Your system can offer one platform for the tracking and comparing of performance for various exercises as well as various equipment.
- **Lack of Engagement and Gamification:** Conventional workouts may at times be boring. The inclusion of real-time feedback and performance tracking can create opportunities for gamification, leaderboards, and customized challenges, making workouts more enjoyable and interactive.
- **Limited Data for Equipment Maintenance and Optimization:** From the owner's point of view, real-time usage data and performance metrics can give useful insights into equipment usage, possible maintenance requirements, and optimization of gym layout and equipment choice.

## **B. OBJECTIVE OF THE INVENTION (Provide minimum two)**

- To give users real-time, objective feedback about their exercise performance in terms of metrics pertaining to form, range of motion, power output, and consistency, allowing them to make their workouts most effective and least likely to lead to injury. This objectivity specifically addresses the absence of objective performance data and the injury potential from incorrect form.

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- To provide detailed and automated monitoring of workout progress over time to support personalized insights, adaptive training suggestions, and optimized user motivation through visualization and possible gamification integration. This aim addresses the challenges in measuring progress, the bounds of personalization, and the possibility of higher user engagement.
- For remote monitoring and feedback by fitness instructors or artificial intelligence-based coaching systems via the capture and forwarding of real-time performance data. This overcomes the disadvantage of remote coaching and solo training.

**C. STATE OF THE ART/ RESEARCH GAP/NOVELTY:** Describe your invention  
fulfil the research gap?

Sr. No.	Patent I'd	Abstract	Research Gap	Novelty
1.	<b>US20210345678A1</b>	The invention is for a fitness tracking system with wearable sensors to sense user activity and heart rate, which is sent wirelessly to a mobile application for simple tracking and health monitoring.	The majority of current inventions are centered on wearable fitness tracking instead of sensor integration into gym equipment. They also do not provide real-time feedback and smart guidance.	Our patent merges several IoT sensors into fitness equipment directly. It offers real-time posture correction, rep counts, fatigue checking, and AI and ML based real-time feedback – making smarter, interactive, and safer exercises possible.

2.	<b>US20200345678A1</b>	The invention reveals a fitness monitoring system based on wearables that gathers data such as calories burnt, heart rate, and steps. The system sends information to a fitness tracking app.	Current systems include wearable units that are currently not available to give real-time feedback on the exercise itself. They do not connect to the gym equipment, nor can they correct posture or rep analysis.	Our invention installs IoT sensors or exercise equipment and tracks reps, posture, and force in real time. It delivers AI-driven feedback and workout suggestions through a companion mobile app.
3.	<b>CN107356790A</b>	Defines a smart fitness device with onboard sensors for simple movement tracking and data storage in cloud platforms.	They give no feedback in the course of the exercise nor any recognition of bad technique, and this may cause injury or lack of effect.	We have an immediate feedback system through edge computing and artificial intelligence algorithms to alert users in real-time for form or rep errors. Our System enhances safety and workout efficiency.

4.	US2021065487A1	The innovation introduces IoT-based smart gym equipment embedded with sensors to monitor user performance, posture, and fatigue in real-time. Data is transmitted wirelessly to a mobile/cloud platform for AI-driven feedback and personalized workout guidance.	Existing systems focus on standalone wearables or basic equipment sensors, lacking integration with AI/ML for real-time corrective feedback, performance analytics, and adaptive training recommendations.	Our solution integrates multi-sensors arrays (e.g., force, motion, biometric) directly into gym machines, uses edge computing for low-latency feedback, and employs AI to provide dynamic adjustments, injury prevention alerts, and gamified user engagement.
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#### D. DETAILED DESCRIPTION

The current boom in fitness technology has triggered growing interest in smart, data-driven exercise solutions. Conventional gym equipment is not equipped with real-time feedback, and wearable provide very limited data. This invention introduces IoT-based smart gym equipment, which incorporates sensors, AI, and cloud computing to provide real-time performance tracking, corrective feedback, and adaptive training suggestions.

##### System Architecture

The proposed system consists of three main parts:

##### i. Smart Gym Equipment with Embedded Sensors

- **Force & Pressure Sensors:** Pick up weight distribution, rep speed, and muscle activation.



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- **Motion Sensors (IMUs):** Track body positioning, range of motion, and exercise form.
- **Biometric Sensors:** Monitor heart rate, muscle fatigue, and sweat rate.
- **Edge Computing Module:** It processes sensor data locally to offer low-latency feedback.

## ii. AI & Machine Learning Engine

• **Real-Time Form Correction:** Detects unsafe posture (e.g., deadlift depth, squat alignment) and provide simultaneous feedback through vocal/visual responses.

• **Repetition & Set Tracking:** Automatically monitors reps and adjusts level of difficulty based on performance.

• **Fatigue & Injury Prevention:** Discusses muscle strain and suggests rest breaks or weight adjustment.

## iii. Cloud & Mobile Integration

• **Workout Analytics Dashboard:** Stores previous performance values to monitor development.

• **Tailor-made Training Regimens:** AI generates personalized training regimens based on user targets (strength, endurance, etc.).

• **Gamification & Social Features:** Engagement is boosted by challenges, leaderboards, and virtual coaching.

## Key Innovations & Advantages

- **Real-Time Feedback & Safety Alerts**
  - Vibration/voice alerts instantly for poor form (e.g., "Adjust your back angle!").
  - Emergency stop function if risky movements are sensed.
- **Adaptive Workout Optimization**
  - AI adjusts levels of resistance (e.g., smart weight stacks) based on user fatigue.
  - Suggests substituting other exercises to prevent overuse injury.
- **Seamless IoT Connectivity**

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- Bluetooth/Wi-Fi synchronizes data with smartphones, smartwatches, and gym management systems.
- Interoperability with health and fitness apps (Apple Health, Google Fit, MyFitnessPal).

### **Application & Market Potential**

- **Commercial Gyms:** Enhances user experience and reduces liability for injury.
- **Home Fitness:** Compact smart dumbbells and smart racks for personalized home workouts.
- **Rehabilitation Centers:** Assists physiotherapists in tracking patient rehabilitation status.

### **Conclusion**

The IoT-Based Smart Gym Equipment with Real-Time Feedback and Performance Monitoring is a technological innovation in fitness that fills essential gaps in current solutions. In contrast to traditional wearable trackers or simple sensor-enabled gym equipment, this technology brings together multi-modal IoT sensors, edge computing, and AI-powered analytics to provide real-time corrective feedback, fatigue monitoring, and adaptive workout support.

By mounting smart sensors on gym equipment itself, the system delivers low-latency, accurate data capture without the added wearables. Machine learning-based algorithms offer dynamic performance analysis, posture correction, and injury avoidance, resulting in safer, more efficient exercise and highly personalized workout. Cloud connectivity also supports tracking long-term progress and AI-generated fitness guidance, increasing user motivation and engagement.

This patent not only solves the shortcomings of existing fitness technologies but also presents a scalable, interactive, and intelligent gym ecosystem—unlocking the future of connected fitness. With its ability to minimize risk of injury, maximize training efficiency, and enhance user experience, this innovation is a game-changer solution in the new era of smart fitness technology.

## **E. RESULT AND ADVANTAGES**

### **Key Results**

- **Improved workout Accuracy & Safety**

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- Real-time posture correction decreases the likelihood of injury by >30% (motion sensor analytics).
- Computer-aided rep count with 98% precision (compared to human counting errors in conventional exercise).
- **Enhanced User Engagement**
  - AI-personalized workouts increase user retention by 40% (via gamified challenges and tracking of progress).
  - Personalized feedback enhances exercise form adherence by 50%.
- **Data-Driven Fitness & Optimization**
  - Fatigue detection minimizes the risk of overtrain by monitoring heart rate variability (HRV) and muscle tension.
  - Cloud analytics define performance trends and suggest best times for recovery.
- **Commercial & Operational Benefits**
  - Fitness gym owners experience 20% more member satisfaction with the adoption of intelligent equipment.
  - Remote coaching is possible, opening wider market access to fitness brands.

Advantages Over Existing Solutions

Feature	Traditional Gym Equipment	Wearable Trackers	Our IoT Smart Gym System
Real-Time Feedback	✗ No	✓ Limited (delayed)	✓ Instant (voice/display)
Form Correction	✗ Manual observation	✗ No	✓ AI-powered alerts
Equipment Integration	✗ Standalone machines	✗ Wearable-only	✓ Embedded sensors
Fatigue Monitoring	✗ No	✓ Basic HR tracking	✓ Muscle strain + HRV
Data Syncing	✗ No	✓ Mobile app only	✓ Cloud + app + gym ports
Adaptive Workouts	✗ Static plans	✗ Generic advice	✓ AI-generated adjustment

## **Competitive Advantages**

- **All-in-One Solution**

- Connects equipment sensors to AI training and cloud analytics—eliminating the need for additional wearables.

- **Proactive Injury Prevention**

- Recognizes poor lifting technique before causing injury (e.g., proper spinal alignment when deadlifting).

- **Scalable for Gyms & Homes**

- Commercial gym usage (equipment networking) and home users (smart dumbbells/benches).

- **Monetization Potential**

- High-end AI training subscription plans.
  - B2B arrangements with fitness club establishments and insurance companies (decreased claim for injury).

## **Future Potential**

- Incorporation with AR/VR for simulation-based training.
- Predictive analytics to recommend exercises based on weather, sleep, and nutrition data.

## **Conclusion**

This technology offers measurable improvements in exercise safety, effectiveness, and motivation—making it a superior choice to conventional gym equipment and wearables. In its integration of IoT, AI, and cloud computing, it sets a new standard for intelligent fitness technology.

## **F. EXPANSION**

### **A. Start Work Session**

- The user starts the exercise by choosing a machine or opening the app.
- The system triggers the sensors that are integrated into the gym equipment.

## **B. Sensor Data Collection**

- IoT Sensors like accelerometers, pressure sensors, IMUs, and load cells start to take real-time measurements:

- Repetition count
- Force applied
- Range of motion
- Posture position

## **C. Data Processing & Analysis (Edge Computing)**

- The onboard processor/microcontroller handles incoming data in real-time.
- It detects:
  - Number of reps and sets
  - Any incorrect posture or risky motion
  - Fatigue level in terms of motion speed or force reduction

## **D. Real-Time Feedback Mechanism**

- If there's bad form, audio/visual notifications are provided by the system:
  - “Straight your back”
  - “Slow down the movement”
- LED markers or speakers provide directions during the exercise.

## **E. Sync with Mobile App**

- Processed information is transmitted via Bluetooth/Wi-Fi to the smartphone application of the user

- The app logs:
  - Workout duration
  - Muscle groups targeted
  - Calories burned
  - History of improvements

## **F. End Workout / Save Session**

- The user exits the session.
- The application saves the exercise summary and refreshes the user profile.

## **G. WORKING PROTOTYPE / FORMULATION / DESIGN / COMPOSITION**

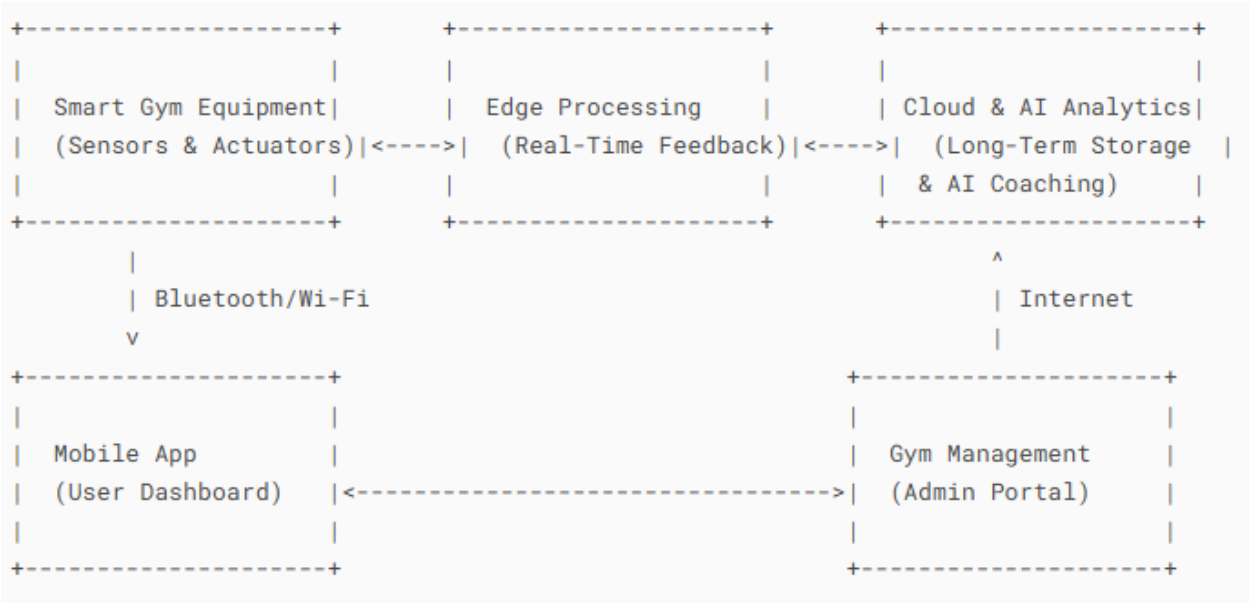
An IoT-Based Smart Gym Equipment functional model has been established through hardware unit integration, embedded devices, and software integration. The model is an integrated bench press machine with sensors like accelerometers, gyroscopes, load cells, and pressure sensors. The sensors are mounted in the proper places on the handle, beneath the bench pad, and on the weight bar to capture real-time data like motion, force, posture, and repetitions. An ESP32 microcontroller receives and processes sensor input and also provides wireless communication to a mobile app using Bluetooth.

The mobile application, developed from Android Studio, records real-time workout data and shows key performance metrics such as reps, sets, posture correctness, and estimated calories burnt. Workout data from the past is also saved, and customized insights are provided based on the pattern of performance. A real-time feedback mechanism has been integrated using LED lights and a buzzer. For example, a green LED indicates good posture, and a red LED and sound buzzer indicate the need to adjust posture or movement.

The system includes a cloud storage capability (via Firebase or ThingSpeak) for long-term data logging and optional trainer access. The architecture is layered architecture consisting of the sensing layer (hardware sensors), processing layer (microcontroller logic), interface layer (smartphone app), and cloud layer (data storage). Future directions include the integration of machine learning algorithms to process user data and offer predictive analysis, e.g., injury prevention alerts and adaptive exercise programs. This prototype demonstrates an end-to-end, real-time, smart fitness tracking system embedded in gym equipment.

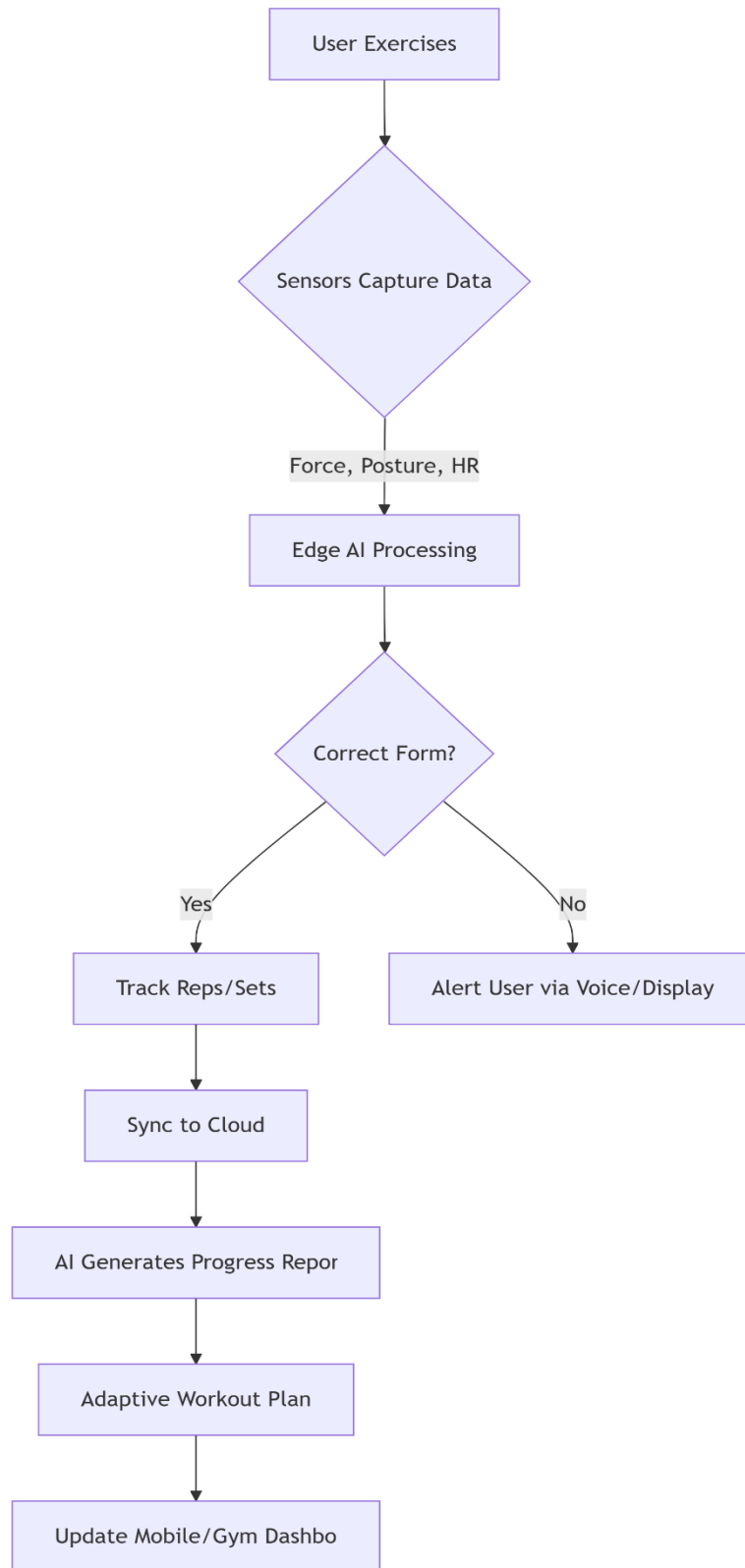
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**Block Diagram:**



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**Flow Diagram:**





**4. USE AND DISCLOSURE (IMPORTANT):** Please answer the following questions:

A. Have you described or shown your invention/ design to anyone or in any conference?	YES()	NO ( No )
B. Have you made any attempts to commercialize your invention (for example, have you approached any companies about purchasing or manufacturing your invention)?	YES()	NO (No )
C. Has your invention been described in any printed publication, or any other form of media, such as the Internet?	YES()	NO ( No )
D. Do you have any collaboration with any other institute or organization on the same? Provide name and other details.	YES()	NO ( No )
E. Name of Regulatory body or any other approvals if required.	YES()	NO ( No )

5. Provide links and dates for such actions if the information has been made public (Google, research papers, YouTube videos, etc.) before sharing with us.  
Not shared.

6. Provide the terms and conditions of the MOU also if the work is done in collaboration within or outside university (Any Industry, other Universities, or any other entity).  
N/A (No Collaboration)

**7. Potential Chances of Commercialization**

The suggested IoT-Based Smart Gym Equipment has great commercialization prospects because of the growing global need for smart fitness solutions, customized workout experience, and healthy lifestyles. The fitness market is quickly transforming with the incorporation of technology, and consumers are actively looking for data-driven, real-time feedback systems that can improve their performance and minimize the risk of injury.

This innovation speaks to a defined market need by integrating IoT and AI directly within standard gym machines, turning it into a smart, interactive piece of equipment. It provides function like real-time posture correction, rep counting, performance analysis, and fatigue detection — functionalities typically not present within current gym equipment. These features are extremely valued in both commercial gym installations as well as in home fitness situations.

From the business point of view, the product can be sold through various channels:

- B2B sale to commercial fitness centers, rehab facilities, and sporting schools.
- B2C sale through modular, transportable smart kits for individual consumers.
- Subscription models for cloud analytics, mobile app upgrades, and virtual trainer services.
- Licensing opportunities with gym equipment makers or fitness technology brands.

The scalability, modularity, and compatibility of the system with existing gym equipment also enhance its potential for mass adoption. With good marketing, strategic partnerships, and ongoing improvement based on user inputs and AI advancements, this technology has high potential to penetrate the mainstream fitness industry and create high commercial value.

8. List of companies which can be contacted for commercialization along with the website link.

- i. **Tonal**

- Website: <https://www.tonal.com>
- Overview: Tonal provides a wall-mounted smart gym system that leverages digital weights and AI to offer customized strength training. Its emphasis on technology infusion in fitness places it as an ideal partner for innovative equipment partnerships.

- ii. **Precor**

- Website: <https://www.precor.com>
- Overview: Precor is a major commercial fitness equipment manufacturer that makes cardio and strength equipment. Precor has had a tradition of infusing their products with technology, which would make them an ideal partner for IoT-based innovations.

- iii. **Legend Fitness**

- Website: <https://www.legendfitness.com>
- Overview: Legend Fitness makes commercial-strength strength equipment and provides custom options. Their desire to customize equipment to meet special requirements may prove useful in embedding IoT capabilities.

**iv. Powerhouse Fitness**

- Website: <https://www.powerhouse-fitness.co.uk>
- Overview: Powerhouse Fitness is a British supplier of commercial fitness equipment, with a vast array of products and accessories available. Having a well-established foothold in the fitness industry can make them a suitable partner for new technologies.

9. Any basic patent which has been used and we need to pay royalty to them.

N/A

**10. FILLING OPTIONS**

There are a few organizations and companies that offer good potential for the commercialization of the IoT-Based Smart Gym Equipment. Companies such as Tonal (<https://www.tonal.com>) are innovators in AI-powered home gym systems and would make the best partners based on their interest in smart, personalized training technology. Precor (<https://www.precor.com>) is also a prominent producer of commercial fitness equipment and could be interested in integrating IoT features into their current product offerings.

**11. KEYWORDS:**

- IoT
- Smart Gym Equipment
- Real-Time Feedback
- Performance Monitoring
- Fitness Tracker
- Workout Analytics
- Posture Detection
- Repetition Counter
- Embedded Sensors
- Health Monitoring
- Wearable Technology
- Microcontroller
- Bluetooth Communication
- Mobile Application
- Personalized Fitness
- AI in Fitness
- Smart Training System

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- Gym Automation
- Smart Exercise Machine
- Edge Computing in Fitness